TO THE

COMMISSIONERS for the Preſervation of the Harbour of *Wells*, in the County of *Norfolk*.

The REPORT of JOSEPH HODSKINSON, Engineer, reſpecting the State of *Wells* Harbour, in the County of *Norfolk*, 1782.

GENTLEMEN,

The Navigation obſtructed.

FROM my Views, Surveys, and Obſervations made thereon in *March* and *April* 1782, I found the Navigation of this Harbour much obſtructed by the Crookedneſs and Irregularity of the Channel, and the Shoals and Sand-Banks left therein by the Tides.

State of the Low-water Channel at Sea.

Set of Flood Tide.

To inform myſelf of the Cauſes of theſe Obſtructions and Impediments, I firſt inquired of ſeveral Pilots and Harbour-Maſters (a) belonging to this Port, into the ancient and preſent State of the Low-water Channel at Sea againſt the Mouth thereof, both as to its Diſtance from the Shore, and Height of its Surface, in order to judge whether the Cauſe of theſe Obſtructions originated from any Changes of the Channel, Sand-Banks, or Currents in the main Ocean; and I found that the State of the Low-water Channel was the ſame then as it had immemorially been, both as to its Diſtance from the Shore and Height of its Surface, for that the Line of Direction for the lower or outermoſt Buoy was then, and had immemorially been, *Brancaſter Mill* and *Burnham Point*. I then inquired into the Manner and Direction of the Influx of the Tides into the Mouth of this Harbour, and was informed, that at the Firſt of Flood the Set of the Tide or Current at Sea runs from the Point of *Foulneſs* paſt the Harbour of *Wells*, in a W. N. W. Direction, to the Point of *Hunſtanton* for Six Hours, and joins itſelf with the Ebb Tide ſetting out of *Wells* Harbour, and both run to the W. N. W. together during the Space of Three Hours (being the Firſt Part of the aforeſaid Six Hours) and then the Water is at its loweſt Ebb, and that then the Tide of Flood begins to act upon the Shore, and gradually enters the Mouth of the ſaid Harbour, the Tide or Current having then Three Hours to run to the W. N. W. which finiſhes the Courſe of the Weſtern Tide.

(a) *James Powditch*, Harbour-Maſter and Pilot, aged 40 Years.
Peter Fairweather, Mariner and Pilot, aged 64 Years.
John Mountain, Mariner and Pilot, aged 53 Years.
John Springold, Mariner, late Harbour-Maſter, and Surveyor of the Works.
John Matſell, Mariner, aged 76 Years.
William Powditch, a Pilot, aged 30 Years.
Thomas Bird, ditto, aged 35 Years.

The Channel ſhifted to the Eaſtward.

Difficulty of Ships coming in.

Going out.

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I was alſo informed, that the Harbour towards its Mouth had ſhifted above a Mile to the Eaſtward within theſe 23 Years laſt paſt, as deſcribed in the Plan annexed by the Letters AA; but that the main Channel before that Time uſed to run on the Weſtern Side of the Scolph at B, and from thence in a N. W. Direction into the Sea, which made the Entrance of the Harbour very commodious and ſafe for Ships, as they then came in always in a S. E. Direction, before the Tide, that is, with the Set of Tide at Sea, as at Arrows E. E. whereas, ſince the Shifting of the Channel to the Eaſtward, the Navigation is become very dangerous, by reaſon of the ſtrong Tide ſetting to the E. S. E. which forces the Ships to ſail in againſt the Tide, that is, in a W. and W. by N. Direction. For Inſtance, when a Veſſel of Burthen wants to come into the Harbour, the Time of coming in ſhould be at or about Half Flood, at which Time the Set of the Tide turns at Sea, as at Arrows EE, and renders it impoſſible for Ships to come up from the Turn at the Second Buoy at F, to the Scolph at G, unleſs the Wind blows ſtrong from the Eaſtward; but this was by no Means the Caſe when the Harbour's Mouth was in the old Direction, as at dotted Line CC. Again, when a Ship of Burthen wants to go out of the Harbour, the Time ſhould be at the Firſt Quarter's Ebb, when the Current at Sea ſets over the Sands as at EE; but it is now impoſſible for a Ship to get from the Second Buoy at F, over the Bar at A, to Sea, unleſs the Wind blows freſh from the South.

Reflux of the Tide at Wells Quay and Warham Slade.

I was alſo informed, that by the Time the Weſtern Tide or Tide of Flood had finiſhed its Courſe, the Waters reach *Wells Quay* at I, and then the Tide turns to the E. S. E. at Sea, acroſs the Harbour's Mouth, as at Arrows EE, and runs for the Space of Six Hours: That during the firſt Three Hours of the Tide's running to the E. S. E. it ſtill continues to flow at *Wells Quay*, and that it uſed to flow about One Hour longer upon *Warham Slade*, N° 7, ſhaded red: That when it was High Water upon *Warham Slade*, the Tide was fallen about Six Feet at the Harbour's Mouth, and that then the Ebb Tide began to make its Way from the Quay to Sea, and that when ſunk about Two Feet at the Quay, then the reflowing Waters began to make their Way from *Warham Slade*, and being joined by other reflowing Waters, from different Creeks and Channels, ran with great Rapidity in a *confined Channel* to Sea: That the Ebb Tide at Sea having then about Two Hours to run to the E. S. E. and its Force being of courſe very much weakened, the

Its Effects.

the ebbing Waters from the Slade, Creeks, and Channels, being much ſtronger than the ſaid Ebb Tide at Sea, uſed to force their Way into the main Ocean, and then run for about Three Hours in a N. W. Direction, until the Tide at Sea began to return in a W. N. W. Direction paſt the ſaid Harbour, and then the Ebb Tide from the ſaid Harbour, having about Three Hours or Half its Time to run, was carried along with the Flood Tide at Sea in a W. N. W. Direction, and by that Means the Channel was kept open in a N. W. Direction, as at CC.

I was alſo informed, that by Means of the Flow and Reflow of the Tides in Manner herein before-mentioned, the ſaid Harbour, Creeks, and Channels uſed to be ſcoured, cleanſed, and kept open, and all the Sand and Silth, which was conſtantly brought up by the Tides, was carried back again, and prevented from lodging therein and choaking up the ſame; and that the ſaid Harbour did then afford an uſeful and commodious Navigation for Ships and Lighters, to the great Benefit and Convenience of Merchants and others trading to and from *Wells* aforeſaid.

Humber and Lynn Channels.

I enquired of Navigators, whether they had obſerved any Alterations in the Channels of the *Humber* or *Lynn Deeps*, to which the Defects in this Harbour could be attributed, and was informed, that the Tides in thoſe Channels acted in quite different Directions, and not towards the Mouth of *Wells* Harbour, ſo that the Harbour could not poſſibly be affected by the Tides coming either from the *Humber* or *Lynn Deeps*.

As to the Sea retreating from this Coaſt.

I alſo aſked the ſaid Navigators whether they had obſerved that the Sea had retreated from this Coaſt within their Memories; they anſwered it had not, but that on the contrary it had gained in many Parts thereof, particularly at *Hunſtanton*, *Cromer*, and *Holkham*, which laſt Place adjoins to the Pariſh of *Wells*.

Times of Flow into the Harbour.

In order to prove the Truth of the foregoing Informations, on the 29th Day of *March* (it being then Full Moon) I proceeded to the Harbour's Mouth, at A, where I arrived at Low Water or thereabouts (it being Twelve o'Clock) and I ſtayed there till the Tide began to flow, which it did at Twenty-five Minutes after One, there being then Eighteen Inches Depth of Water upon the Bar, at A, and the Wind then blowing a ſtrong Gale from the S. W. and by W.

From hence I proceeded to the Pool at H (diſtant from the Harbour's Mouth about Two Miles) where the Tide began to flow at Three o'Clock.

At *Wells Quay*, I, (diſtant from the Pool Eight Furlongs and a Half) the Tide began to flow at Thirty-nine Minutes paſt Three o'Clock.

At the Bank made by Sir *John Turner*, at K, (diſtant above the Quay Six Furlongs) the Tide began to flow at Twenty-one Minutes paſt Four o'Clock.

High-Water ditto.

I alſo found that it was High-Water at the Mouth of the Harbour about Six o'Clock.

At *Wells Quay*, I, Forty-ſix Minutes paſt Six o'Clock.

At Sir *John Turner's Bank*, K, at Fifty Minutes paſt Six o'Clock.

Warham Slade.

The High-Water of the aforeſaid Tide at Sir *John Turner*'s Bank, K, was higher than the Surface of *Warham Slade* (N° 7) by Two Feet Eight Inches and a Half, which ſhews that (had the Slade been open) it would have been covered Two Feet Eight Inches and a Half by this Tide.

I alſo found by the Wreck of a large Tide, which happened about Six Months before, that the ſame roſe Three Feet higher than the aforegoing, which Tide would have covered the Surface of *Warham Slade* (had it been open) Five Feet Eight Inches and a Half.

From theſe Inquiries and Obſervations, I am fully ſatisfied that the Information given to me as aforeſaid is founded on Truth.

Interior View.

From hence I concluded, that the Cauſes of theſe Obſtructions were not to be ſought in the main Ocean; and therefore I turned my Inquiries internally, and examined the State of the Harbour and adjoining Country from Low-water Mark at Sea to *Wells*, and from thence upwards thro' *Warham Slade* to the *Shepperd's Houſe*, at L, and alſo the Plans thereof taken by the late Mr. *Elſtobb* and Mr. *Turpin*, and alſo that taken by Mr. *Biederman (b)*.

The Influx of the Tides on the Marſhes.

This Harbour is a collateral Branch of the Sea, extending thro' a ſandy and chingly Beach, and low and flat Marſhes called *Salt Marſhes*, lying on each Side thereof, containing before any Imbankation thereon about *Two thouſand Five hundred and Sixty-five* Acres, as deſcribed in the Plan by the Green, Blue, Yellow, and Red Shades, and numbered 1, 2, 3, 4, 5, 6, and 7.

(b) Mr. *Beiderman*'s Plan is incorrect at the Eaſt End of the *Great Eaſt Fleet*, near *Broad Arſe*——As there certainly is (and I am informed there always was) a Paſſage to Sea from the Out-Marſhes, at the Eaſt End of the *Great Eaſt Fleet*.

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In theſe Marſhes there are a large Number of deep Channels and Creeks, formed by the Operation of the Tides.

The Influx of the Tide at the ſame Time that it filled the Harbour, uſed heretofore to fill all the Channels and Creeks, and in large Spring Tides overflowed the Whole of theſe Salt Marſhes, and thereby formed a natural Reſervoir which contained a Body of Water covering *Two thouſand Five hundred and Sixty-five* Acres.

Natural Reſervoir of 2565 Acres.

The Tides flow about Three Hours and Seven Minutes, and ebb Eight Hours and Fifty-three Minutes at *Wells Quay*, I; and flow about Two Hours and Twenty-nine Minutes, and ebb Nine Hours and Thirty-one Minutes at Sir *John Turner's Bank*, K; and it appears that, if that Bank had not been raiſed, the Tide of the Sea would have ebbed off, and the Water would have fallen very conſiderably at the Mouth of the Harbour, at the Time when the Water at the upper Extremity of *Warham Slade*, near the *Shepperd's* Houſe, L, would have been at its full Height: And this vaſt Body of Tide-water upon its Reflux acting with an accelerated Velocity, and for a great Length of Time upon the Harbour ſo emptied, uſed heretofore to grind and carry away the muddy Matter brought therein by the Influx of the Tide, and to keep open and deep the Channel from *Wells* to the Sea, thereby forming a good and perfect Navigation. In which State (as I was informed) it continued till ſeveral Imbankations were made, and large Quantities of Salt Marſhes taken in and cut off from the Action of the Tides.

Flow and Reflow.

Their Effects.

Theſe Imbankments, being Three in Number, were the Subject of my particular Inquiries, as to the Quantities of Land imbanked, and the Effects they had upon the Harbour.

The Firſt Imbankation, which I ſhall mention, incloſed a certain Piece of Marſh Land which belonged to the late Lord *Leiceſter*, together with another Piece of Marſh Land which was incloſed by the late Sir *C. Turner*, both lying on the Weſt Side of the Harbour (ſee the Plan N° 1 and 2, ſhaded Blue); theſe Imbankations incloſe in the Whole about *Six hundred and Sixty-eight* Acres, and were made (as I am informed) upwards of Sixty Years ago.

Imbankment of the Weſt Marſhes by Lord Leiceſter and Sir Charles Turner.

The Second Imbankation was made about the ſame Time as the Firſt, and incloſed a Piece of Marſh Land lying on the South Side of the Harbour of *Wells*, and containing about *One hundred and Ten* Acres, which is called *The Church Marſh*, and is marked on the Plan N° 6, and ſhaded Yellow; and I obſerved, that in making this Bank the Engineer (Mr. *Kenderly*, a Man of Experience in

The Church Marſh by Sir Charles Turner.

Kenderly's Bank.

his Profeſſion) ſeemed to have been aware of the Damage which this Harbour would have thereby ſuſtained, if he interſected the main Channel at K, and therefore at a very conſiderable Expence more than would have attended ſuch an Interſection (altho' Sir *Charles Turner* would thereby have gained a larger Quantity of Land) he carried his Bank in the Direction O O O O, leaving the ſaid main Channel open to the Harbour.

Warham Slade, the Imbankment in queſtion, by Sir John Turner.

The Third Imbankation was made by the late Sir *John Turner*, about Twenty-four Years ago (as I was informed) and incloſed another Piece of Marſh Land, marked in the Plan N° 7, and ſhaded Red) which contains about *Sixty-ſix* Acres, called *Warham Slade*, Part thereof lying in *Warham* and the Remainder in *Wells*.

Reaſons on the Effect of the Warham Slade Imbankment.

Theſe Imbankations contain together about *Eight hundred and Forty-ſix* Acres, being about One-third Part of all the ſaid Marſhes, Channels, and Creeks, and are, in my Opinion, the ſole Cauſe of the Obſtructions formed in this Harbour; becauſe by thus leſſening the re-acting Power of this great and natural Reſervoir, the Operation of the Tides has been weakened, and the counter Action of the Reflux rendered incapable of grinding out and carrying away the muddy Matter brought in by the Influx, as it uſed heretofore to do, and becauſe there are no material living Waters falling into this Harbour to aſſiſt the ſaid Reflux.

But the miſchievous Effects of theſe Imbankations are not all alike, but proportionate to their Situation and to their Diſtance from the Harbour.

Effects on the different Imbankments.—Wells Marſhes.

The Firſt Imbankment (N° 1 and 2) whereof *Four hundred* Acres only drained into the Harbour, was not productive of ſuch ill Effects as the Second and Third Imbankments, becauſe all the Waters in this Imbankment, ſave and except thoſe contained in the Creeks and Channels thereof, uſed to reflow to Sea at the Firſt Quarter's Ebb, and before the Channel from the Pool to Sea was ſufficiently emptied to receive the ſame; and therefore, inſtead of paſſing through the Channel, all theſe Waters, except the ſmall Quantity contained in the Creeks or Channels, went with the Eaſtern Tide to Sea, and never had any ſcouring or grinding Effect on the Harbour.

Church Marſh

The Second Imbankment (N° 6) was, in my Opinon, of greater Hurt to the Harbour than the Firſt, becauſe its Situation is more diſtant from the Harbour's Mouth, and conſequently the Reflux of the Tide Waters acted longer thereon, and the Time they acted in the Channel there was during the laſt Quarter's Ebb.

Friſton's Sluice.

And it is evident, that theſe Two Firſt Imbankations were attended with great Miſchief to the Harbour, becauſe about the Year 1748 (as I was informed) a Sluice or Jetteau called *Friſton's Sluice* or *Jetteau* was erected, and other Expedients uſed, in order to keep back a Quantity of Water from the Marſhes lying on the Eaſt Side of the Channel, by way of Reſervoir, to remedy the Loſs of Waters the Harbour had ſuſtained by theſe Imbankments, and to let the ſame off upon the Tide of Ebb; but theſe Expedients did not laſt long (as I was informed) yet while they did, ſome Benefit was found thereby.

Warham Slade Imbankment.

By the Third and laſt Imbankment made by the late Sir *John Turner* (at K), *Warham Slade*, and the Creeks and Channels therein, were incloſed, and the main Channel or uppermoſt Part of the Harbour itſelf, in Extent about One Mile and a Half, were wholly loſt, from Sixty-ſix Acres of Land, which that Imbankment contained.

This Imbankment of *Warham Slade* was, in my Opinion, far more detrimental to the Harbour than the former Imbankments, N° 1 and 2, becauſe the Body of Tide Waters contained therein did not reflow to Sea till the laſt Quarter's Ebb, and as the Waters in the lower Parts of the Channel had before that Time ebbed off to Sea, ſo theſe Waters had on their Reflow a grinding and ſcouring Effect throughout the whole Navigation, and more particularly ſo, as they entered the Harbour in a true Line of Direction; and the Injury muſt appear greater when it is known, that the Harbour does not afford any Expedient to ſupply the Want thereof.

In order the more fully to explain the Degrees of Miſchief this Harbour has ſuſtained by the Loſs of the Back Waters taken from it by the aforeſaid Imbankments, and their Effects on the Reflow wholly loſt, I have calculated their Quantities and Weights, which I find at *a low Computation* to be as follows; *viz.*

THE WEST MARSHES.

Calculations.

Part of the Marſhes imbanked by the late Lord *Leiceſter* and Sir *Charles Turner* on the Weſt Side of the Harbour, N° 1 and 2, containing about *Four hundred* Acres, diſcharged their Surface Waters into the lower Part of the Channel, and the Quantity, amounted to *Four hundred Ninety eight thouſand* Tons; but theſe Surface Waters never had any grinding or ſcouring Effect on the Harbour, as they went off to Sea at the Firſt Quarter's Ebb, and before the Channel from the Pool to Sea was ſufficiently emptied to receive the ſame.

	Tons.	*Tons.*
The old Channels and Creeks in the ſaid *Four hundred* Acres which drained into or had any ſcouring Effect on the Harbour, ſuppoſing them to be opened to their former Dimenſions, contained -		74,699
Note. The Water upon the remaining Part of the imbanked Marſhes, (N° 1 and 2) paſſed to Sea through other Courſes, but did not communicate with the Haven.		

THE CHURCH MARSH.

The *Marſhes* imbanked by Sir *Charles Turner* called *The Church Marſh* (N° 6) containing about *One hundred and Ten* Acres, diſcharged their Waters into the Harbour above the Quay, I; which Waters had a grinding and ſcouring Effect throughout the whole Navigation, and ſuppoſing the *Marſhes* to be overflowed at common Spring Tides Two Feet deep *only* (though in large ones they muſt have been overflowed Four Feet and a Half) theſe Surface Waters amounted to - - - - - - - - - - - - - -	273,900	
The old Channel and Creeks therein, ſuppoſing them opened to their former Dimenſions, contained - - - - - -	19,913	
The total Body of Water contained in the *Church Marſh* amounted to - - - - - - -	293,813	293,813
And the total Body of Water contained in the Imbankments of 1719, which had any ſcouring Effect on the Harbour, amounted to - - - -		368,512

WARHAM SLADE.

Warham Slade (N° 7) embanked by Sir *John Turner* in 1758, containing about *Sixty-ſix* Acres, diſcharged its Waters into the Harbour about Six Furlongs above the Quay, and the Quantity of Surface-Waters, (ſuppoſing the *Slade* to be overflowed Two Feet deep *only* at common Spring		

	Tons.	Tons.
Brought forward, - -		368,512
Spring Tides (though in large ones it was overflowed Four Feet and a Half) amounted to - - - - - - - - -	164,340	
The old Channel and Creeks therein, ſuppoſing them to be opened to their former Dimenſions, contained - - -	49,782	
The total Body of Water contained in *Warham Slade* amounted to - - - - - - - - - -	214,122	214,122
The MARSHES *now remaining open and unincloſed.*		
Note. Theſe Marſhes (N° 3, 4, 5) contain about *One thouſand Seven hundred and Nineteen* Acres: All the Surface-Waters therein, amounting to 2,140,155 Tons, reflow to Sea at the Firſt Quarter's Ebb, and never have any grinding or ſcouring Effect on the Harbour.		
The Fleets and Creeks therein, Eaſt and Weſt, with the Sluice Waters which drain into or have any ſcouring Effect on the Harbour, contain - - - - - -		468,120
The total Body of Waters in all the Marſhes, Channels, and Creeks, before any Imbankation whatſoever, which had any ſcouring Effect on the Harbour, amounted to - - - - - - - - -		1,050,754

Inferences on the Imbankment of 1758.

	Tons.
From the aforeſaid Calculations it appears, that the Waters which had any ſcouring Effect on the Harbour did, before any Imbankation whatever, amount to	1,050,754
Of which Waters the Harbour was deprived by the Imbankments in 1719 of	368,512
Therefore the Waters were *then* reduced more than One-third of their original Weight, *viz.* to	682,242

Which laſt Body of Water did, as I am informed, with the ſmall Aſſiſtance it received for a few Years from Mr. *Friſton*'s Sluice or Jetteau erected in 1748, operate in ſuch a Manner as to keep and preſerve the Mouth of the Harbour in its old Direction, and the Channel ſufficiently open, deep, and wide for the Purpoſe of Navigation, until ſome Time in or about the Year 1758, at which Time the laſt Imbankment was erected for incloſing *Warham Slade*.

On all the Imbankments

If, then, this Body of Water (*viz. Six hundred Eighty-two thouſand Two hundred and Forty-two* Tons) was ſufficient (as it appears) for the above beneficial Purpoſes, and if the preſent bad State of the Harbour commenced at that Period, it now becomes neceſſary to aſcertain the Body of Water of which the *Warham Slade* Imbankment deprived the Harbour, and from thence to point out its Effects.

	Tons.
Firſt then it appears, that *Warham Slade* contained of Water	214,122
Which being added to the Waters of which the Harbour was deprived in 1719, *viz.*	368,512
will prove, that by all the Imbankments the Harbour has been deprived of more than One-half of its original Stock, or of	582,634

On the Warham Slade Imbankment in 1758.

But as the Imbankments of 1719 have been erected above Sixty Years, and cannot (as I am informed) be now removed or called in queſtion, it is proper to ſhew the Proportion of Water of which the Harbour was deprived by the Imbankment of *Warham Slade*, compared with the Body of Water which ſcoured the Harbour and preſerved the Navigation as aforeſaid from 1719 to 1758.

	Tons.
It appears, that after the Imbankment of 1719 there remained a ſufficient Quantity of Water for ſcouring the Harbour, *viz.*	682,242
By the Imbankment for incloſing *Warham Slade*, erected by Sir *John Turner* in 1758, the Harbour was deprived of	214,122
	468,120

By which the Waters left in 1719 were thereby reduced nearly One-third, and only *Four hundred Sixty-eight thouſand One hundred and Twenty* Tons were left to aſſiſt the main Channel in its Reflux to Sea.

Concluſion drawn from the foregoing Obſervations.

When the Situation of *Warham Slade* and its Diſtance from the Harbour's Mouth, together with the Direction and the Time in which the Waters from thence entered the navigable Channel is attended to; and when the foregoing Calculations (by which it appears, that nearly One-third Part of the Waters which ſupplied the Harbour, and maintained the Navigation from 1719 to 1758 as aforeſaid, was cut off) are conſidered, it muſt follow as a neceſſary Conſequence, that the Imbankment of *Warham Slade* in 1758 was very prejudicial to the Harbour; and the chief Cauſe of all thoſe Evils and Impediments which now exiſt therein. The Reſervoir of Water upon *Warham Slade* was formed by Nature, and was in point of Situation ſuperior to all the other Reſervoirs adjoining to this Harbour. For upon the Return of the Tides the Waters muſt firſt begin to ebb in the lower Parts of a Channel before the Waters in the upper Parts can give way; and it is known, that in the upper Parts of a Channel, at a conſiderable Diſtance from its Mouth, the Tide will be flowing up, and the Motion of the Water upwards will be retained after it has long ebbed, and much fallen at the Mouth and lower Parts of it; from whence it is plain that the Water at the Quay at I, and at the lower Parts of this Haven, muſt have greatly ſubſided and moſt or all of the Sands and Marſhes bordering thereon muſt have been uncovered and laid dry before the Ebb-Waters from *Warham Slade* could be paſſed off; and as their Power and Force was increaſed by the Increaſe made to their Fall by the more early ſubſiding of the Waters in the lower Parts of the Haven, ſo their Power and Force in ſcouring, cleanſing, and preſerving the navigable Part of the Channel through which the Ships and Veſſels conſtantly paſſed and repaſſed, was very great; the Waters therefore from *Warham Slade* muſt have been very beneficial to the Purpoſe of Navigation and Commerce. And here it may not be amiſs to obſerve, that the more remote from the Mouth of a Channel, and the larger the Receptacles for the Tide-Waters are, the greater will be their Power of cleanſing, ſcouring, preſerving, and improving that Channel, as both the Quantity and Velocity of the Ebb and Back Waters will be increaſed by theſe Circumſtances.

And if the Waters left after the Imbankments of 1719 did as aforeſaid exactly counterbalance (by their Reflux or Re-action) the Miſchiefs occaſioned by the Influx from that Time to 1758, what muſt be the Conſequence if nearly One-third of this Re-action is deſtroyed?

deſtroyed? The Anſwer is evident: Theſe Miſchiefs, occaſioned by the Influx, muſt remain in the Channel and Haven, and can only be imputed to the Loſs of thoſe reflowing Waters.

To explain the Grounds and Principles of my Opinion, I beg Leave to refer to Sir *William Dugdale's Hiſtory of Imbanking and Draining*, which was wrote in 1662, where will be found ſeveral Decrees and Ordinances concerning Imbankments—And to *Serjeant Callis's Reading on the Statute of 23d of Hen. VIII. of Sewers*, page 54. And for the ſame Purpoſe I have ſubjoined an Appendix, containing Extracts from Reports made by ſeveral eminent Engineers, and from other Compoſitions upon the Subject of Imbankments.

It has been ſaid, that Reſervoirs have been uſed in *France* and elſewhere, with Succeſs, for keeping Harbours open and clean; I anſwer, if Reſervoirs are proper Expedients in this Caſe, no Place to make them in can be ſo eligible as *Warham Slade*, that being at the upper Extremity of the Harbour.

Upon the Whole I am of Opinion, that the preſent bad and ruinous State of the Harbour is to be, in a great Meaſure if not wholly imputed to the Imbankment of *Warham Slade* in 1758, and that if the Tide of the Sea is permitted to flow and reflow in its ancient Courſe and Manner over *Warham Slade*, (*c*) and if the Harbour's Mouth and Channel ſhould be firſt cleanſed and reſtored to its former Poſition, the Navigation will be ſupported and maintained in a ſafe, uſeful, and commodious State by the natural Operation of the Tidal Waters thereon; and that the Harbour will be more benefited, and more likely to anſwer the Purpoſes of Navigation and Commerce, by the natural Support of the Waters from *Warham Slade*, than by any artificial Means whatſoever, within the Harbour, which can be executed without an Expence too heavy for the Trade of the Port to bear.

Theſe, Gentlemen, are my Sentiments, ſubmitted to your Conſideration,

29 MR 59

And am,

Your moſt Obedient

And very humble Servant,

Arundel-ſtreet, Strand,
London, 5th *July* 1782.

J. Hodskinson.

(*c*) **And in the old Creeks and Channels therein.**

APPENDIX.

Colonel Armstrong, *in his Report of the 12th of May* 1724, *concerning the Drainage of* Bedford Level *and the Port of* King's Lynn, *Pages* 2 *and* 3, *expreſſes himſelf to the following Effect:*

Armſtrong, 1724.

“THE great Cauſe of the Decay of *Lynn* Harbour, in conſequence whereof the Fens could not drain off their Waters, was principally owing to the Tides being ſhut out of their ancient Receptacles, viz. the *Ouſe*, *Stoke*, *Brandon*, *Mildenhall* and *Grant* Rivers, by the Dam and Sluices erected at *Denver*; and this evidently appears, in that juſt before thoſe Sluices were built the Tides made clean Work in *Lynn* Haven, and maintained the River and Channel of ſufficient Width and Depth for Navigation and Draining: Soon after thoſe were erected theſe grew up and became incapable of draining, and precarious to Navigation.”——*Again*——

“And the Reflux of the Tides was heretofore ſo ſtrong, that they did not only ſcour out the Sands (brought in by the Flux) back again to Sea, but enlarged and deepened the River, Haven, and Channel (as may appear by the authentic Teſtimonies of the Commiſſioners of Sewers, the Petitions of *Marſhland*, Mr. *Richard Atkins*, &c.) until the Works of the Adventurers weakened the ſaid Reflux; and therefore when theſe Works are laid aſide, and the Tides and Freſhes are permitted to have their antient Courſe, they will ſeparately, and in Conjunction, work the Effects they formerly did, and preſerve a ſufficient Channel.” ——*Again,* Page 12——

“*Oſtend* did decay, when ſome Marſhes were embanked and the Indraft was leſſened, until thoſe Banks were deſtroyed, and the old Indraft was again recovered.”——*Again*——

“*Rye* Harbour, &c. has decayed by having ſuch Indrafts taken away by Inners of Marſhes, and we ſay, if private Men, to get a little Land, may be guilty of ſuch Encroachments, all our Ports may be ruined in Time, in the ſame Manner that *Lynn*, *Wiſbeach*, and *Rye* have been.”

Mr. **Badeslade**, *in his Treatiſe on the ancient and preſent State of the Navigation and Ports of* King's Lynn *and* Cambridge, *publiſhed in* 1725, *Pages* 13 *and* 14, *expreſſes himſelf to the following Effect:*

Badeſlade.

“ And that the Ebb of the Tide alone, excluſive of the freſh
“ Waters, does ſcour and grind away to Sea the Silt brought up
“ by the Flood, and principally maintain their Channel, is demonſtrable:
“ The Harbour and Channel of *Wells* in *Norfolk* is
“ maintained and kept open by the Sea Water only (no freſh Water
“ River having its Outfall there) the Sea putting up its Tides
“ into a great many Creeks, which occaſions a great Indraft, the
“ Water being received into thoſe Receptacles does in its Ebb keep
“ open the Harbour, Channel, and Pool; and though the Sea does
“ leave ſome Sand in the ſaid Creeks during the Neap Tides, and
“ the Channel rather grows up than deepens, yet the next Spring
“ Tides overflowing a large Tract of Salt Marſhes, the ſaid
“ Water, on the Retreat of the Tide, falling off thoſe Marſhes
“ into the ſaid Creeks, does drive out the Sand dropped in them
“ during the Neap with ſuch Force to Sea, that it grinds them
“ and the Channel and Pool, and makes them deeper than they
“ were before the Spring Tides put up.”

“ But ſince a conſiderable Number of Acres of Salt Marſh has
“ been imbanked and taken in adjoining to the Port of *Wells*, and
“ ſeveral Creeks have had Banks run acroſs them; which hinders
“ the Neap Tides from putting up into thoſe Creeks, as they were
“ wont to do, and alſo the Spring Tides from overflowing the
“ Quantity of Marſh they uſed before to cover; the ſaid Harbour
“ of *Wells*, its Channel and Pool, have very ſenſibly decayed, as
“ have done all Channels that have been any-ways deprived of
“ their antient Stock of Back Waters.”

Thus Mr. **Atkins** *writes:*

“ *Spalding* of old Time was beſt of Three Outfalls, now the
“ worſt; loſt by winning certain Severals to the Sea-ward.”

Sir **Cornelius Vermuyden** *expreſſes himſelf to the following Effect:*

“ The *Ouſe* from *Littleport* to *Lenne* keeps its Depth by reaſon
“ of the Back Waters.”—*Again*—

“ The

“ The Floods and Ebbs of the Sea maintain *Boſton Deeps.* The
“ Reaſon why it keeps ſo deep is, that the Ebbs which come over
“ the Sands which lie between *Norfolk* and theſe Waters, come
“ that Way, and ſo make a Deep there, which could not otherwiſe
“ be poſſibly maintained. It is not the River *Welland*, and that of
“ *Boſton* could do it; they are but ſmall Waters, and the leſs
“ powerful when they come abroad into a vaſt Place where they
“ are not to be diſcerned; ſo that if it were not for the Ebbs of
“ the Sea, it would ſoon decay.”

See an ingenious Pamphlet, entitled—“ Some Thoughts on “ Mr. *Roſewell*'s and other Schemes now propoſed for “ amending *Lynn* Channel and Harbour.” *Page* 11.

Anonymous.

“ It is known by Experience, that the Excluſion of the Tide-
“ Waters is ſometimes the Ruin of a Harbour; as is evident in
“ the Inſtance of *Wells* Harbour, which, while it had large Recep-
“ tacles for the Tide-Water above the Town, was by the Reflux
“ of that Water, paſſing off every Ebb through the narrow Channel
“ along the Key, preſerved in a tolerable good Condition; but
“ ſince theſe Receptacles have been taken away by Imbankments,
“ the Return of all that Water is loſt, and the Harbour quite ruined
“ for want of it.”

Mr. Langley Edwards, *in his Report for the amending the Outfall of the River* Nene, *&c. dated* 16*th April* 1771, *Page* 5*th, expreſſes himſelf to the following Effect:*

“ The Three great Cauſes of the Deſtruction of the Outfall
“ which have happened in our Times have been—Firſt, the Im-
“ bankment of Marſhes (made about Fifty Years ſince) which
“ lie below the preſent Waſh-way, and were overflowed by every
“ Spring Tide, which, in its Reflux, deſcended by large Creeks,
“ and kept a good Channel either by *Terrington Hole* or the *Eye*
“ downwards to Sea.”

To the COMMISSIONERS for the Preſervation of the Harbour of *Wells*, in the County of *Norfolk*.

GENTLEMEN,

HAVING accompanied Mr. *Hodſkinſon* in his Survey of the Harbour of *Wells*, in purſuance of your Directions, We join and entirely concur in his Report dated the 5th Inſtant.

We are,

GENTLEMEN,

Your moſt obedient Servants,

26 MR 59

JOHN GRUNDY.

6th *July* 1782. THOMAS HOGARD.

TO THE

COMMISSIONERS for the Preſervation of the Harbour of *Wells* in the County of *Norfolk*.

The REPORT of JOSEPH NICKALLS, Engineer, on the State of *Wells* Harbour in *Norfolk*, in 1782.

GENTLEMEN,

IN purſuance of your Directions I did, on the 12th Day of *June* laſt, and on the Six following Days, take a Survey of the Harbour of *Wells* and adjacent Country, and upon comparing the ſame with the Plan annexed, and receiving much Information on the Spot, and inſpecting the Plans made by Meſſieurs *Ellſtobb* and *Turpin*, and by Mr. *Biederman*, it appears to me that the Map annexed is correct.

From the aforeſaid View and Information I found, that the Channel from its Mouth to the Weſt End of *High Bink*, or South End of the Scolph (G) being more than One Mile and a Quarter in Length, is in its preſent State perilous and uncertain for Ships coming in or going out UNDER ANY WIND WHATSOEVER; and that the Navigation under *many Winds* is wholly impracticable. This Impediment or Miſchief to Navigation ariſes from the ſerpentine Form of the Channel (AA) and the Shoals and Sand-Banks therein.

Near the Scolph I took particular Notice of what (I was informed) was the Line of Direction of the old Channel (CC) to Sea, and I obſerved a viſible Indentment or Track in the ſaid Line, which, joined to the Information given to me on the Spot, induces me to think was the Weſt Boundary of the ſaid old Channel, and it appears to me, that the Courſe of that Channel was the natural Paſſage from the Pool to Sea, and that it would have been preſerved and maintained in its old Direction by the ſame Means which at firſt created it, if thoſe Means had not been taken away: For while the Channel was in that Courſe (CC) the Flood and Ebbs of the Tides had ſufficient Power to keep the ſame open, deep, ſtraight, and clear of Sand-Banks, which they could not poſſibly have done, if it had been in its preſent Line of Direction; becauſe the Tides coming up and going down in a crooked Courſe, muſt

muſt always have formed many Eddies, occaſioning Depoſits of Matter, and from thence muſt have aroſe Shoals and other Obſtructions to Navigation. If it was neceſſary, I could refer to many Places in England, where large Sums of Money have been expended in remedying the Miſchiefs occaſioned by crooked Channels.

When I took a View of the Spot called *High Bink* I found it (and it evidently appears to be) of a very advantageous Form, and in ſuch a Situation as to operate as a Jetteau, and to give the Tidal Water a true Line of Direction to and from the Pool in the old Channel. This Spot is compoſed of ſuch Matter as to render it of great Stability, for it has retained its old Poſition without ſhifting, notwithſtanding the Change of the Channel and the different Operations of the Tidal Waters thereon.

Theſe Obſervations and Facts induce me to be moſt clearly of Opinion, that the Change in the Poſition of the Channel from the Scolph to Sea, and the Crookedneſs of its Courſe, is not to be imputed to any external Cauſe; I therefore enquired whether any Alterations had been made in the Marſhes, Channels, and Creeks near the Harbour, or in the Courſes of the Tides, to which the preſent bad State of the Navigation could be attributed, and was informed of the ſeveral Imbankments made on the Weſt and Eaſt Sides of the Harbour, N° 1, 2, and 6.

I compute that the Marſhes N° 1, 2, 6, imbanked in 1719, containing about 779 Acres of Land, uſed at many Spring Tides before and after the EQUINOXES, and at other Times in the Year, to receive on their Surface and into the Channels and Creeks therein about 4,239,155 Tons of Water, Part of which paſſing *High Bink*, and on the Weſt Side of the Scolph, had a great Effect in ſcouring the Channel, and partly contributed to the Preſervation and Maintenance of the Harbour in its old Direction.

By the Imbankments of 1719, the Haven was deprived of a great Body of Water, notwithſtanding which, as I am informed, the Harbour, with the Aſſiſtance of Mr. *Friſton's* Sluice and other temporary Expedients, was maintained in its old Courſe, and in a good navigable State, until ſome Time in or about the Year 1758, which leads me to the Conſideration of the Imbankment of *Warham Slade* at (K), and the Effects it had upon the Harbour.

The Body of Water contained in *Warham Slade* amounting (as I compute the ſame) to 456,402 Tons, was more effective in ſcouring the Channel, than the Waters on the Marſhes imbanked in

in 1719, N° 1 and 2, becauſe the Marſhes, N° 1 and 2, were very near the Harbour's Mouth, and the Waters from thence ebbing much ſooner than thoſe contained in *Warham Slade*, N° 7, could do little more than cleanſe their own reſpective Channels and their Collaterals; whereas the Waters from *Warham Slade* were not only effective in ſcouring their own Channels to the Quay, but by Reaſon of their late ebbing and joining with the Waters from other Channels, operated effectually on the Quay and on the whole Navigation. The Waters from *Warham Slade*, from their great Deſcent and the Length of their Courſe, acquired great Velocity and Force, and the lower Parts of the Channel, being nearly emptied before the Return of theſe Waters, were wholly left to their Power, and the ſame paſſing in a narrow Courſe and receiving Aſſiſtance of Water from the Sluice and different Creeks and Channels, and a good Line of Direction from the Point of Land at *High Bink* and the South End of the Scolph, did, as I am informed, keep the Channel ſufficiently wide, deep, and in its old Direction to Sea, from 1719 to 1758; and I am of Opinion, that if the Waters from *Warham Slade* had been ſtill permitted to flow and reflow in their natural Courſe, as before the Imbankment thereof, the ſame would have continued to produce the ſame Effects upon the Harbour as they uſed to do, and would have maintained a good and deep Navigation from the Quay to Sea as aforeſaid.

There are no Waters near this Harbour which paſs through the ſame in ſo commodious a Direction upon their Reflux, as the Waters from *Warham Slade*; and if any artificial Means ſhould at any Time be thought neceſſary, this Harbour does not afford a more commodious and proper Spot (whereon they might be erected) than *Warham Slade*.—I mention this, becauſe, notwithſtanding the immenſe Expence which the Town of *Wells* have been put to in artificial Conſtructions to ſupply the Loſs of Water occaſioned by the Imbankments, yet their Purpoſe has not been anſwered; and indeed all artificial Works muſt ever be liable to Objections, which cannot be made to the Operations and Effect of Nature.

To ſhew the great Utility of the Waters from *Warham Slade*, I meaſured the Current thereof at a Furlong below the Bank (K) and I found them to run no more than Sixty-one Feet and a Half in a Minute; and if the *Slade* had been then open, the Current would have been ſo much greater as to have exceeded that of moſt Rivers; and therefore I am of Opinion, that if the Imbankment (K) was removed, the Waters from *Warham Slade* would then operate in ſuch a Manner as to reſtore the Navigation, and to prevent ſuch Obſtructions and Evils (as now exiſt in the Channel) for

the

the Time to come, and that in ſuch Caſe there would be no Occaſion for the Erection of any artificial Works whatever.

As it may at firſt View appear that my Calculations exceed thoſe of the other Engineers conſulted by the Commiſſioners upon the Buſineſs in Queſtion, I think it right to obſerve, that I have conſidered the Tides before and after the Equinoxes, and many others of like Height, as the great, efficient, and operative Tides.— Attending to this Obſervation, the Commiſſioners will find, that the Calculations nearly agree.

I have been informed, that the Exiſtence of *Wells* Harbour has been imputed to *Chance*—If it is conſidered, that the Sea has Acceſs to and from the Parts adjacent to *Wells*, containing a large Tract of Country, over which the Tide Waters always flowed, and that thoſe Waters had no Paſſage except through the Haven, and that the Ends of the *Weſt* and *Eaſt Fleets*, next the Haven, are by much the loweſt, I believe that it will not be thought too bold in me to ſay, that whoever was the Author of the above Imputation, could not have any great Knowledge of the Nature of Harbours, or the natural Means by which they are preſerved.—It may not, however, be amiſs to give ſome Account of Harbours, whoſe Exiſtence may be imputed to Chance with as much Propriety as the Harbour of *Wells*, and which have little or no Aſſiſtance, except what they derive from the natural Operation or the Flux and Reflux of the Sea.

No freſh Waters of any Conſequence paſs thro' *Milford* Haven.

Plymouth, the *Sound*, and *Hamoaze* receive no freſh Waters, except a very inconſiderable Quantity from the little River *Tamer*—a little River paſſes through *Catwater*.

Portſmouth Harbour receives a trifling Quantity of freſh Water from a ſmall overſhot Mill at *Farham*; but the Quantity is ſo ſmall as ſcarce to deſerve Notice.

The fine and deep Harbours of *Langſton* and *Chicheſter* have been always ſupported ſolely by the Flux and Reflux of the Tides.

The Harbour of *Selſey* very much reſembles that of *Wells*, prior to the Year 1758, and never had any freſh back Water.

The Harbour of *Rye*, once famous, was chiefly kept open by the natural Operation of the Tidal Waters thereon; though at laſt it was ruined by Imbankments; whereupon Capt. *Perry*, in the Beginning of this Century, ſurveyed it, and in conſequence of his

Recom-

Recommendation a new Harbour was made in another Place.—In the Year 1762 this Harbour was ſurveyed by Mr. *Smeaton*, who, by his Report of the 16th of *February* 1763, propoſed a Plan for collecting a Body of Water for the Purpoſe of ſcouring the Harbour, and in his Eſtimate the Expence of the Works neceſſary for collecting nearly or about 733,415 Tons of Water was computed at £26,751.

If *Warham Slade* is opened, and the Tidal Waters permitted to flow and reflow therein, as heretofore, Nature will then ſupply the Harbour of *Wells* with much more Water from *Warham Slade* and the unimbanked Marſhes, than, according to Mr. *Smeaton's* Eſtimate, could be obtained for the Harbour of *Rye* for £26,751.

I am told, that the Harbour of *Wells* (being ſituated near a fine Country for the Production of Corn) is the Second Harbour for the Exportation of Malt within the Kingdom of *Great Britain*, as well as a good Nurſery for Seamen; and therefore the Importance of the Matter referred to me by the Commiſſioners, has induced me to give more than common Attention to the Subject of this Report; and I am fully of Opinion, that unleſs the Imbankment of *Warham Slade* is removed, and the Tidal Waters permitted to flow and reflow therein, as they uſed heretofore to do, this Harbour muſt be deſtroyed. I am,

GENTLEMEN,

Your moſt obedient Servant,

Southwark,
July 5th 1782.

JOSH NICKALLS.

THE

REPORTS

OF

Meſſ. HODSKINSON, GRUNDY, HOGARD, and NICKALLS, on the State and Cauſes of the Decay of *Wells* Harbour.

1782.

26 MR 3